

HARVARD ASTROPHYSICAL CONFERENCE.—Several items in the report of this conference have already been noticed, but in the pamphlet now distributed by Prof. M. B. Snyder, of the Philadelphia Observatory, there are some points of interest.

Mrs. Fleming presented a paper on stars of the Vth type in the Magellanic clouds. These stars have spectra consisting chiefly of bright lines, and are usually known as Wolf-Rayet stars. Up to 1897 the number of these objects known was 67, and all lie closely along the central line of the Milky Way. Photographs taken at Arequipa with the Bruce telescope revealed 21 of these objects in the large Magellanic cloud, 3 others in the Milky Way, and 1 in the small Magellanic cloud, bringing the total number up to 92. Of these fifth-type stars 22 are thus in the Magellanic clouds, and this large proportion renders probable the connection of these objects with the Milky Way.

Mr. E. S. King described an ingenious method of converting prismatic spectra into normal spectra. To do this the original plate is inclined to the plate on which the copy is to be made, by an amount calculated to make the scale exact for three points in its length, while at the same time maintaining good focus. As illustrations he showed several stellar spectra compared with Rowland's map of the solar spectrum. Prof. Pickering said that the method was perfectly general, and all scales were thus reproducible.

Mrs. Fleming, in a paper on classification of spectra of variables of long period, describes the characteristics of these objects. About 100 stars of this class are known, and all have the hydrogen lines bright. Examination of the relative intensities of these lines has led to the class being divided into eleven groups, of which two are mentioned in detail. One group, represented by R Lyncis, has a spectrum resembling α Tauri, but having H β and H γ strongly bright, while H δ is barely visible. Another group, typified by R Leonis, shows a continuous spectrum with H β invisible, H γ barely visible, and H δ strongly marked.

Prof. G. E. Hale presented a review of work on the spectra of stars of Secchi's fourth type. These are the blood-red stars, and the spectra of twenty-two of them have been obtained with the spectrograph of the 40-inch Yerkes telescope, mostly with a dispersion of one prism. For the two brightest stars of this class, 132 and 152 Schjellerup, three prisms were employed. The photographs show a large number of lines hitherto unrecorded, most of which are dark; but it is stated that there seem to be a number of bright lines.

The presence of bright lines in 152 Schjellerup was, it is stated, confirmed by Profs. Keeler and Campbell at the Lick Observatory. The wave-lengths of two of the brightest of these lines agree very closely with those of the two brightest lines in the Wolf-Rayet stars, as measured by Campbell; but no connection between these two classes of bodies is yet indicated. A reproduction of the photographed spectrum of 152 Schj. is published in the *Ast. Phys. Journ.*, November 1898.

THE PLAN OF THE EARTH AND ITS CAUSES.¹

IN a passage in the "Novum Organum" Bacon pointed out resemblances between the continents of the Old and New Worlds, which he thought showed that their shapes were not due to chance, but to the action of a common cause. Similar coincidences have been repeatedly noticed by geographers, who have accordingly been led to the belief that the distribution of land and water on the globe is based on a definite plan. Any such plan can only be recognised in broad outline, since geographical shapes depend on an intricate series of local accidents. Topographical form depends on such inconstant, incalculable factors that the stages of its growth are often untraceable. The missing links of geographical evolution are as numerous as those of organic evolution. Nevertheless, belief in the existence of a fundamental geographical plan is as old as geography. It was expressed in some of the earliest classical maps; it possessed the minds of mediæval cartographers, and led to their fantastic wheel maps; and it was popularised in the first half of the present century by the teaching of Humboldt and Élie de Beaumont. But with the growth of Lyellism and its doctrine of the interchange of land and sea under the influence of local variations in level, the idea fell into discredit.

¹ Abstract of lecture to the Royal Geographical Society on January 23, by Dr. J. W. Gregory.

But the discoveries of oceanography and geology have shown what allowances should be made for the obscuring action of minor oscillations, and thus have revealed fresh geographical homologies and explained apparent exceptions. The introduction of such local changes is, however, unnecessary, since the existence of a geographical plan of the earth is shown by three features: (1) the concentration of land in the northern, and of water in the southern hemisphere; (2) the triangular form of the geographical units, and the southward tapering of the land masses. From these two features it follows that there is a "northern land belt" from which three continents project southward, separated by three oceans, which expand until they form a "southern ocean belt." The third feature is the antipodal position of oceans and continents. The main problem of geomorphogeny is the explanation of these three facts.

The question is simplified by remembering that the earth consists of three parts: (1) the unknown internal centrosphere; (2) the rocky crust, or lithosphere; (3) the oceanic layer, or hydrosphere. Oceans and continents occupy, respectively, depressions and elevations of the lithosphere; and their distribution, therefore, directly depends on the distribution of the irregularities in its surface. If the existing irregularities have remained unchanged throughout geological time, then the problem is astronomical rather than geographical and geological.

The attempts to solve the problem on the basis of the permanence of the main geographical features may be grouped into four sets: (1) Prof. G. H. Darwin has attributed the main geographical lines to tidal wrinkles in the viscous crust; (2) Prinz has assigned them to torsion due to the acceleration of the equatorial and southern belts of the earth, and retardation of the northern land belt; (3) Sir J. Lubbock and Prof. Lapworth have independently explained continental form as due to the intercrossing of two sets of folds, one parallel to the equator and one at right angles to it; (4) Lord Kelvin refers back the main geographical divisions to an even earlier period than the previous theories; for he regards them as due to shoaling in the last molten layer of the globe, over areas determined by previous chemical segregations in the nebula. These theories are not necessarily inconsistent with the asymmetry between the northern and southern hemispheres; the primitive wrinkles, the double folds, and the nebulous segregations are each in harmony with a considerable amount of geological evidence; but the theories are geographically inadequate, because they do not explain how the existing asymmetry has been developed. To do this, some more continuously acting cause is required, such as the secular contraction of the earth, on which Élie de Beaumont based his famous theory. His system, however, regarded the world as symmetrical, and was too rigidly geometrical to apply satisfactorily to a heterogeneous globe. In his "pentagonal réseau" antipodal areas were similar; for he regarded the world as a spheroid based on a pentagonal dodecahedron, which is a holohedral form; whereas, owing to the dissimilarity of antipodes on the earth, the lithosphere may be better regarded as hemihedral. The recognition of this fact led to the great advance on Élie de Beaumont's theory made by Lowthian Green, which has been advocated by de Lapparent and Michel-Lévy.

The tetrahedral theory does not regard the world as a regular tetrahedron; but suggests that, owing to the collapse of the earth's crust due to contraction, the lithosphere has undergone a tetrahedroid deformation. That collapsing shells tend to become tetrahedral, just as short tubes often collapse trigonally, is shown by experiments. "Nothing," says E. D. Preston, "is more in accordance with the action of physical laws than that the earth is contracting in approximately a tetrahedral form. . . . Experiments on iron tubes, on gas bubbles rising in water, and on rubber balloons, all tend to bear out the assumption that a homogeneous sphere tends to contract into a tetrahedron."

If such be the case, then the lithosphere would be depressed on four faces, which, being lower, would be naturally occupied by oceans; while the four projecting coigns would stand up as continents. In such a tetrahedrally deformed earth there would be a central ocean (the Arctic) on one face surrounded by a land belt, from which three meridional continents would run southward; they would each taper to a point, below which would be a southern ocean belt, from which three oceans would project northward. South of the ocean belt would be an Antarctic continent.

The arrangement of land and water on such an ideal, de-

formed globe would be identical with that on the earth; for there would be a northern concentration of land, and a southern excess of water; the geographical shapes—except in the case of the two polar units—would be triangular, and land and water would be antipodal.

The agreement between the facts of geography and the requirements of the tetrahedral theory goes further. The main watersheds and mountain systems—which are by no means coincident—have both a tetrahedral plan, forming a girdle in the northern hemisphere and three approximately equidistant meridional lines in the southern hemisphere.

The first obvious objection to the hypothesis of tetrahedroid deformation of the lithosphere is that physicists having proved the rigidity of the earth, any such deformation is impossible. But the arguments in favour of the earth's rigidity apply to the globe as a whole, and do not debar limited deformation of the crust. Such elasticity is now regarded as demonstrated by the movements of the pole, under such trivial influences as the unequal melting of the polar ice or unbalanced falls of snow. The second objection is that the earth is known to be an oblate spheroid, and therefore is not tetrahedrally deformed. But, owing to the equatorial flattening of the world, it is not a spheroid of revolution; owing to the differences of shape between the northern and southern hemispheres, it is not even an ellipsoid. Herschel pithily stated the facts in his remark that "the earth is earth-shaped"; and Listing's term "geoid" is now generally adopted for the figure of the earth. The geoid is, however, by no means a regular figure; the differences between the astronomical and trigonometrical determinations of positions show that the form is subject to numerous deviations, which cannot at present be attributed to any definite system; for accurate observations have not been made over a sufficiently large portion of the earth. But there are suggestions that, like the physical features of the earth, the major geodetic variations may be on a tetrahedral plan; for there is evidence of great deficiency of gravity in two areas (East Russia and Central U.S.A.), which may represent two of the three minima which should occur in the northern land belt. The ordinary explanation of these deficiencies in gravity—viz. that they are due to vast subterranean blocks of light material—is improbable; because in the Russian case the existence of such blocks is disproved by observations on deviations of the plumb-line (Helmert); and in the American case, Mendenhall has shown that no reasonable, or even possible, assumption will explain the facts. The agreement of gravity observations with Bessel's ellipsoid in Central Europe, and their approximation to Clarke's ellipsoid in Eastern Russia (as shown by Helmert), may indicate that both ellipsoids accurately represent the curvatures of the two areas on which they were mainly based, and that they merge into one another along the line of the East African meridional edge.

Geological evidence gives important support to the tetrahedral hypothesis, for the northern land belt appears founded on three great "schild" (Suess) or "coigns" of Archean blocks; these Scandinavian, Canadian, and Manchurian coigns are 120° apart. The significance of the angular distance between them was first pointed out by De Lapparent in the case of the first two. South of the coigns lines of elevation on the meridional edges would be expected; and, though the geological structure of the country along the three lines differs fundamentally, the three lines of recent or still continuing earth-movements of the Andes, Erythrean rift-valley, and East Australian coast occur in the right positions. That tetrahedral geological symmetry is not only an incident of the present, is shown by the distribution of land and water, and by the arrangement of the mountain system at the end of the Palæozoic; for both were on a tetrahedral symmetry. But in that period the present arrangement was reversed, the land belt being southern and the ocean belt northern in position; the position of the meridional land lines was the same as at present.

Such a change in the areas of tetrahedral flattening would be impossible in a stationary world; but in a revolving globe the collapse, due to contraction, is steadily resisted and confined within narrow limits by the effects of the rotation, which tends to restore the world to the more stable spheroidal form. The great mountain building periods of the earth's history may be due to instability resulting from periods of slow deformation; and the periods of great marine transgressions (e.g. the repeated Mesozoic transgressions after the mountain elevations at the

close of the Palæozoic) are easily explained as due to the restoration of more regular spheroidal form.

Hence the distribution of land and water on the globe may be regarded as the resultant of two opposing forces, collapse due to secular contraction causing deformations, and the tendency due to the earth's rotation towards the recovery of the spheroidal form. The plan of the earth may be attributed to the continuous foundering of the lithosphere in consequence of the unceasing shrinkage of the centrosphere.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

OXFORD.—Among the lectures announced for this Term may be noted:—Prof. Burdon-Sanderson on general pathology, Dr. Ritchie on special pathology, Prof. Thomson on cranial nerves and digestive system, Prof. Esson on synthetic geometry of conics and cubics, Prof. Turner on mathematical astronomy, Prof. Miers on physical properties of crystals, Mr. Bowman on microscopical examination of crystals, Prof. Elliott on elliptic functions, Prof. Clifton on electricity, Mr. Walker on physical optics, Mr. Goodrich on aves and mammalia, Mr. Bourne on Ctenophora, Prof. Odling on the sugars, Mr. Watts on organic chemistry, Mr. Veley on physical chemistry, Mr. Marsh on stereo chemistry, Prof. Gotch on physiology of the excitable tissues, Mr. Burch on physiological physics, Prof. Sollas on evolution of the earth and on palæontology, Prof. Tylor on development of culture, Mr. Barclay-Thompson on sauropsidan morphology and palæontology. The other lectures announced are more particularly devoted to the general subjects required for the schools.

Elections will be made in the course of the present term to the Sedleian Professorship of Natural Philosophy, vacant by the death of Prof. Bartholomew Price, and to the Linacre Professorship of Comparative Anatomy, vacant by the resignation of Prof. Ray Lankester.

CAMBRIDGE.—The Duke of Devonshire, Chancellor of Cambridge University, presided on Tuesday over a meeting at Devonshire House to consider the financial needs of the University and the establishment of a Cambridge University Association. A full report of the meeting appeared in yesterday's *Times*. The Chairman set forth the various requirements of the University, in buildings and endowments, to meet the increased demands of the day, and said that altogether something like half a million was needed. He announced that he would contribute 10,000*l.* to the endowment fund. A contribution of 10,000*l.* was promised from Lord Rothchild's firm, and the Drapers' Company intimated their intention of contributing 800*l.* a year for ten years in support of a Professorship of Agriculture. It was resolved to form a Cambridge University Association for the purpose of enlarging the resources of the University.

THE following gifts to educational institutions in the United States are announced in *Science*:—The late Henry Clark Warren, of Boston, an accomplished Oriental scholar, has left to Harvard University a large sum principally for the Sanscrit department, but including 10,000 dollars for the Peabody Museum of American archaeology and ethnology, and 10,000 dollars for the Dental School. The same University receives 5000 dollars by the will of the late Susan B. Lyman, Dedham, Mass., and 10,000 dollars by the will of the late Mrs. Mary Ann P. Weld, of Boston, the latter sum being for the purpose of founding a Christopher Minot Weld Scholarship. The Teachers' College of Columbia University has received an anonymous gift of 10,000 dollars.

THE Technical Education Board of the London County Council have arranged to award four scholarships of the value of 150*l.* each, tenable from Easter to Christmas 1899, in some higher commercial school or schools on the continent. Candidates must have had experience in teaching commercial subjects, and must possess a good conversational knowledge of the language of the country in which they proposed to hold these scholarships. The Board's object is to afford to teachers who were well acquainted with some branch or branches of commercial education an opportunity of making themselves acquainted with the organisation and methods of the more successful commercial high schools of the continent. Sir Philip